COLOR CORRECT DIGITAL WATERMARKING OF IMAGES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of digital imaging and more particularly to the field of watermarking digital images.

2. Related Art

Digital imagery provides a means for many and/or widely scattered users to have access to a single object, such as a manuscript in a library, an object in a museum, a magazine article, or anything else which can be photographed or scanned. A digital image is a two-dimensional array of picture elements (pixels), each of which describes the color of the object at one point. Digital images may be conveniently stored in a digital computer, transmitted over communications lines, and reproduced at a remote location.

One of the significant deterrents to making large libraries of digital images publicly available is the concern, by the owners of the image content, about misappropriation of their images. In many cases, the owner of the medium from which the image was digitized earns revenue from some uses of the images. In this case the owner typically will wish to prevent the images from being copied and then used, royalty-free. An example of this might be a publisher who makes images available within the context of a digital book or magazine, but who also wishes to prevent the unauthorized copying and use of these images by other publishers. Another example of this might be that of an owner of an art collection who wishes to sell images of art objects in the collection for multimedia presentations, but does not want these images used for publishing books of art.

In other cases, the owner of the media may wish to prevent certain uses for other reasons. A national library, for instance, might be willing to make reproductions of various works available for study, yet unwilling to make them available in any form that might be used to advertise a product, such as pornography, that would be embarrassing to that institution.

Hence, the general problem is to devise techniques that produce images that are totally acceptable for some uses, and yet unacceptable for other uses. Frequently, it is desired to produce images that are entirely acceptable for inspection or study, yet unacceptable for publication. One method of accomplishing this is known as "watermarking".

A simple watermarking method is demonstrated in Jim Pickerell and Andrew Child, *Marketing Photography in the Digital Environment,* 1994. "Image Watermarking for Photoshop", an additional sheet available from the same company, gives instructions for applying a watermark using Photoshop. Pickerell and Child use the technique for protecting electronic catalogs of photographs and "clip art".

While watermarking is an effective way for copyright and media owners to control the use of their images, conventional watermarking processes can alter the chromaticities of the original image at points where the watermark appears. This effect may be undesirable from the perspective of both the viewer and the owner of the original image.

SUMMARY OF THE INVENTION

In light of the above, it is an object of the present invention to provide a digital watermark that preserves the chromaticities of the original image.

Thus, in accordance with an aspect of the present invention, a digital watermark is applied to an original image as a multiplicative correction to pixel sample values of the original image in a linear color space such that the chromaticities of the pixels are not changed.

In a preferred embodiment, a system for placing a visible watermark on a digital image examines the pixels of the watermark. For each pixel whose value is not a specified "transparent" value, the system modifies the corresponding pixel of the original image by changing the brightness but not the color. Advantageously, by ensuring that the color or an image is not changed, the contents of the watermarked image may be viewed clearly, while discouraging unauthorized use of the image.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a block diagram of an image capture and distribution system suitable for use in accordance with an embodiment of the present invention;

FIG. **2** is a functional level block diagram of an embodiment of the present invention;

FIG. **3** is a flow chart of a method of watermarking monochrome images in accordance with an embodiment of the present invention;

FIG. **4** is a flow chart of calculation of a scaling factor used in the method of FIG. **2**; and,

FIG. **5** is a flowchart of a method for watermarking color images in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

a. Color Theory

Before proceeding with a description of the details of the invention, it is useful to present some background in color theory, and to describe the formats in which images to be watermarked are typically stored. Color theory is discussed in more detail in K. Blair Benson, ed., *Television Engineering Handbook,* McGraw-Hill Book Company, New York, 1986.

The sensation of color is evoked by the physical stimulation of light-sensitive elements in the human retina. The stimulation consists of electromagnetic radiation in the "visible" spectrum comprising wavelengths between approximately 380 and 780 nm. The light-sensitive elements, known as "cones", can be separated into three classes, each class being sensitive to a different spectral distribution of radiation. This "trichromacy" of color sensation means that many different spectral distributions can produce the same perceived color.

Because of the phenomenon of trichromacy, any color stimulus can be matched by a mixture of three primary stimuli, so long as none of the three primary stimuli can be matched by a mixture of the other two. All colors having the same tristimulus values will appear to be the same color. A commonly used set of primaries is the combination of red, green and blue, denoted as R, G and B. R, G and B have corresponding tristimulus values R, G and B which represent the component values for a given pixel.

Experimental results have shown that for most practical purposes color matches obey the rules of linearity and additivity. This principle, as applied to color, is known as Grassmann's law. What this means, as a practical matter, is